```
>
>  The microcontroller program is composed of many interactive modules:
>      INIT    system initialization
>      MAIN    main program
>      AU_RG   autoranging loop
>      FTOV    internal timer interrupt service routine
>      CONV    a/d convertion of "rate" and "event filter" knobs
positions
>      ELAB    input data acquisition, computing, event filtering, 1 or 3
notes code generation
>      SCALA   musical notes codes computing (from 12 notes scale to 7
notes major scale)
>      TX_A    serial comunication device transmission routine
>      N_ON    MIDI protocol "note on" string code assembler (calls TX_A
for tx) starts the play of a musical note
>      N_OFF   MIDI protocol "note off" string code assembler (calls TX_A
for tx) stop the play of a note
>      A_ANOFF generates a "all notes off" MIDI string code that
completely silences the sound generator
>      TABLE   label points to the start address of a 12 bytes notes
codes convertion table (h B7F4)
>      TABLE is a 12 byte table with the 12 musical note code for the
conversion from the 12 notes scale to the major harmonic scale.
>Base address in eeprom =  h b7f4
>Bytes     h    00 00 02 02 04 05 05 07 07 09 09 0a (not present in the
>listing, must be programmed in eeprom)


>
>M68HC11 Absolute Assembler    Version 2.70C:MA03.ASC
>
>
>    1 A               **********************************
>    2 A               *    PROGRAMMA MA03 * Z.LAB 1997    *      BASE
B7F4
>    3 A               **********************************      REL.
> TEST    DEV
>    4 A               *
>    5 A               *
>    6 A               *********** VARIABILI ************
>    7 A
>    8 A       0000    A_NTON    EQU       $00
;VALORE
> NOTE ON   CH A
>    9 A       0001    A_NTOFF   EQU       $01
;VALORE
> NOTE OFF  CH A
>   10 A       0002    A_NT1     EQU       $02
;CODA
> NOTE 1
>   11 A       0003    A_NT2     EQU       $03
;CODA
> NOTE 2
>   12 A       0005    A_VEL     EQU       $05
;VALORE
> VELOCITA' CH A (MIDI CH 00)
>   13 A       0006    A_INT     EQU       $06
;VALORE
```

```
>  INTORNO FILTRO EVENTI CH A
>     14 A       0007       A_ADC      EQU        $07
;VALORE
>  DI INGRESSO CH A
>     15
>  A        0009        A_SW       EQU        $09                          ;IMMAGINE
SW CH A
>     16
>  A        000C        A_MSB      EQU        $0C
;AUTORANGE DAC MSB
>     17
>  A        000D        A_LSB      EQU        $0D
;AUTORANGE DAC LSB
>     18 A       000E        A_AR       EQU        $0E
;NUMERO
>  INTERVENTI AU_RG PER SELEZIONE VELOCITA'
>     19 A       000F        A_ARFLG    EQU        $0F
;FLAG
>  AU_RG CH A ON
>     20 A 0000
>     21 A       0020        RATE       EQU        $20
;FREQ.
>  CAMPIONAMENTO ADC - SCANSIONE TEMPORALE
>     22 A       0022        TEMP       EQU        $22              ;VAR
>  SUPPORTO PER SCALA
>     23 A       0023        AR_DEL     EQU        $23              ;E
$24 2
>  BYTES RITARDO PER INCREM E DECREM RTNS
>     24 A 0000
>     25 A 0000
>     26 A                    ** INDIRIZZI ASSOLUTI **
>     27 A
>     28 A       1003        PORTC      EQU        $1003
;PORTC
>     29
>  A        B7F4        TABLE      EQU        $B7F4
;INDIRIZZO
>  BASE TABELLA SCALA MAGGIORE
>     30 A 0000
>     31 A 0000
>     32 A                    ** OFFSETS **
>     33 A
>     34 A       0003        IPORTC     EQU        $03
;PORTC
>  OFFSET
>     35 A 0000
>     36 A 0000
>     37 A 0000
>     38 A                    ****** PROGRAMMA PRINCIPALE ******
>     39 A
>     40 A       B600                    ORG        $B600
>     41 A
>     42 A B600 867E        INIT       LDAA       #$7E
>     43 A B602 97DC                   STAA       $DC
>     44 A B604 CCB724                 LDD        #FTOV
;SETTA
>  VETTORE INT OC2
```

2   Appendix I

```
>    45 A B607 DDDD                    STD      $00DD                      ;PER
> SINGLE CHIP INSERIRE $00DD // $019B
>    46 A B609 CE1000                  LDX      #$1000
>    47 A B60C 4F                      CLRA
>    48 A B60D A72C                    STAA     $2C,X
>    49 A B60F A709                    STAA     $09,X
>    50 A                    *         STAA     $04,X   ;AZZERA PORTB OUT
>    51 A B611 8607                    LDAA     #$07
>    52 A B613 A708                    STAA     $08,X
>    53 A B615 A728                    STAA     $28,X
>    54 A B617 860C                    LDAA     #$0C
>    55 A B619 A72D                    STAA     $2D,X
>    56 A B61B 8610                    LDAA     #$10
>    57 A B61D A72E                    STAA     $2E,X
>    58 A B61F 8620                    LDAA     #$20
;SETT
> BAUD RATE MIDI
>M68HC11 Absolute Assembler   Version 2.70C:MA03.ASC
>
>
>    59 A B621 A72B                    STAA     $2B,X
>    60 A B623 9723                    STAA     AR_DEL
>    61 A B625 970F                    STAA     A_ARFLG
>    62 A B627 4A                      DECA
>    63 A                    *         LDAA     #$1F
>    64 A B628 A707                    STAA     $07,X                      ;DIR
> PORTC  7- 3 INT...5 LED -0
>    65 A B62A 8693                    LDAA     #$93
;ABILITA
> PSU ADC
>    66 A B62C A739                    STAA     $39,X
>    67 A B62E 8632                    LDAA     #$32
;SETTA ADC
>    68 A B630 A730                    STAA     $30,X
>    69 A B632 CC05C0                  LDD      #$05C0
>    70 A B635 DD0C                    STD      A_MSB
>    71 A B637 8640                    LDAA     #$40
>    72 A B639 A720                    STAA     $20,X
>    73 A B63B A723                    STAA     $23,X
>    74 A B63D A722                    STAA     $22,X
>    75 A                    *         LDAA     #$FF
>    76 A                    *         STAA     RATE
>    77 A B63F 0E                      CLI
>    78 A
>    79 A
>    80 A B640 18DE20   MAIN           LDY      RATE
>    81 A B643 1809     R1             DEY
>    82 A B645 26FC                    BNE      R1
>    83 A B647 18DE20                  LDY      RATE
>    84 A B64A 1809     R2             DEY
>    85 A B64C 26FC                    BNE      R2
>    86 A                    *         LDX      #$1000
>    87 A B64E A603                    LDAA     IPORTC,X
>    88 A B650 84E0                    ANDA     #$E0
>    89 A B652 9109                    CMPA     A_SW
>    90 A B654 2705                    BEQ      M1
>    91 A B656 9709                    STAA     A_SW
```
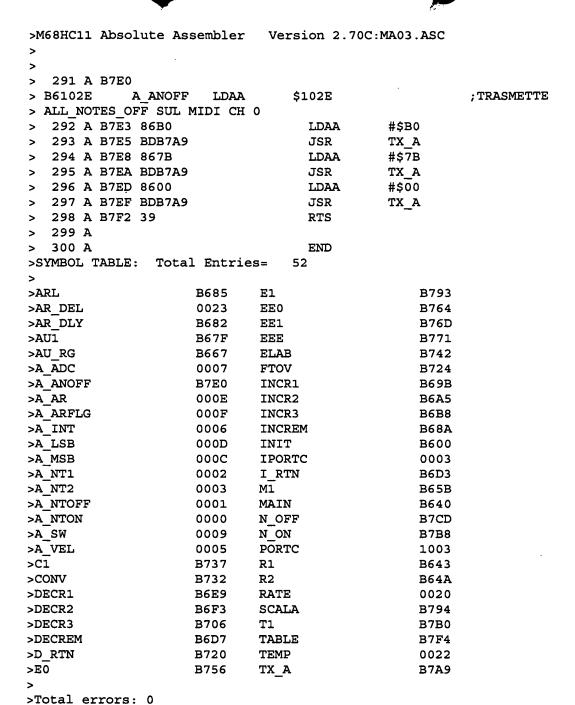
```
>    92 A B658 BDB7E0                    JSR     A_ANOFF
>    93 A B65B BDB732      M1            JSR     CONV
>    94 A B65E BDB667                    JSR     AU_RG
>    95 A B661 BDB742                    JSR     ELAB
>    96 A B664 7EB640                    JMP     MAIN
>    97 A
>    98 A
>    99 A              ************** ROUTINES **************
>   100 A
>   101 A B667 A631      AU_RG         LDAA    $31,X
>   102 A B669 8120                    CMPA    #$20
>   103 A B66B 231D                    BLS     INCREM
>   104 A B66D A631                    LDAA    $31,X
>   105 A B66F 81E0                    CMPA    #$E0
>   106 A B671 2264                    BHI     DECREM
>   107 A B673 86FF                    LDAA    #$FF
>   108 A B675 9723                    STAA    AR_DEL
>   109 A B677 960F                    LDAA    A_ARFLG
>   110 A B679 2604                    BNE     AU1
>   111 A B67B 861B                    LDAA    #%00011011
>   112 A B67D A703                    STAA    IPORTC,X
>   113 A B67F A631      AU1           LDAA    $31,X
>   114 A B681 39                      RTS
>   115 A
>   116 A B682 18DE23    AR_DLY        LDY     AR_DEL
>M68HC11 Absolute Assembler   Version 2.70C:MA03.ASC
>
>
>   117 A B685 1809      ARL           DEY
>   118 A B687 26FC                    BNE     ARL
>   119 A B689 39                      RTS
>   120 A
>   121 A B68A 861D      INCREM        LDAA    #%00011101
>   122 A B68C A703                    STAA    IPORTC,X
>   123 A B68E 960F                    LDAA    A_ARFLG
>   124 A B690 8110                    CMPA    #$10
>   125 A B692 233F                    BLS     I_RTN
>   126 A B694 861E                    LDAA    #%00011110
>   127 A B696 A703                    STAA    IPORTC,X
>   128 A B698 BDB7E0                  JSR     A_ANOFF
>   129 A B69B 960E      INCR1         LDAA    A_AR
>   130 A B69D 8103                    CMPA    #$03
>   131 A B69F 2304                    BLS     INCR2
>   132 A B6A1 8620                    LDAA    #$20
>   133 A B6A3 9723                    STAA    AR_DEL
>   134 A B6A5 18DE0C    INCR2         LDY     A_MSB
>   135 A B6A8 1808                    INY
>   136 A B6AA 188C0800                CPY     #$0800
>   137 A B6AE 2308                    BLS     INCR3
>   138 A B6B0 18CE05C0                LDY     #$05C0
>   139 A B6B4 860C                    LDAA    #%00001100
>   140 A B6B6 A703                    STAA    IPORTC,X
>   141 A B6B8 18DF0C    INCR3         STY     A_MSB
>   142 A B6BB BDB682                  JSR     AR_DLY
>   143 A B6BE B61031                  LDAA    $1031
>   144 A B6C1 8150                    CMPA    #$50
>   145 A B6C3 7C000E                  INC     A_AR
```

```
>   146 A B6C6 23D3                   BLS       INCR1
>   147 A B6C8 7F000F                 CLR       A_ARFLG
>   148 A B6CB 7F000E                 CLR       A_AR
>   149 A B6CE 86FF                   LDAA      #$FF
>   150 A B6D0 9723                   STAA      AR_DEL
>   151 A B6D2 39                     RTS
>   152 A B6D3 7C000F      I_RTN      INC       A_ARFLG
>   153 A B6D6 39                     RTS
>   154 A
>   155 A B6D7 8617        DECREM     LDAA      #%00010111
>   156 A B6D9 B71003                 STAA      PORTC
>   157 A B6DC 960F                   LDAA      A_ARFLG
>   158 A B6DE 8110                   CMPA      #$10
>   159 A B6E0 233E                   BLS       D_RTN
>   160 A B6E2 860F                   LDAA      #%00001111
>   161 A B6E4 A703                   STAA      IPORTC,X
>   162 A B6E6 BDB7E0                 JSR       A_ANOFF
>   163 A B6E9 960E        DECR1      LDAA      A_AR
>   164 A B6EB 8103                   CMPA      #$03
>   165 A B6ED 2304                   BLS       DECR2
>   166 A B6EF 8620                   LDAA      #$20
>   167 A B6F1 9723                   STAA      AR_DEL
>   168 A B6F3 18DE0C      DECR2      LDY       A_MSB
>   169 A B6F6 1809                   DEY
>   170 A B6F8 188C03C0               CPY       #$03C0
>   171 A B6FC 2208                   BHI       DECR3
>   172 A B6FE 18CE05C0               LDY       #$05C0
>   173 A B702 8606                   LDAA      #%00000110
>   174 A B704 A703                   STAA      IPORTC,X
>M68HC11 Absolute Assembler    Version 2.70C:MA03.ASC
>
>
>   175 A B706 18DF0C      DECR3      STY       A_MSB
>   176 A B709 BDB682                 JSR       AR_DLY
>   177 A B70C A631                   LDAA      $31,X
>   178 A B70E 81B0                   CMPA      #$B0
>   179 A B710 7C000E                 INC       A_AR
>   180 A B713 22D4                   BHI       DECR1
>   181 A B715 7F000F                 CLR       A_ARFLG
>   182 A B718 7F000E                 CLR       A_AR
>   183 A B71B 86FF                   LDAA      #$FF
>   184 A B71D 9723                   STAA      AR_DEL
>   185 A B71F 39                     RTS
>   186 A B720 7C000F      D_RTN      INC       A_ARFLG
>   187 A B723 39                     RTS
>   188 A
>   189 A B724 DC0C        FTOV       LDD       A_MSB
>   190 A B726 F31018                 ADDD      $1018
>   191 A B729 FD1018                 STD       $1018
>   192 A B72C 8640                   LDAA      #$40
>   193 A B72E B71023                 STAA      $1023
>   194 A B731 3B                     RTI
>   195 A B732
>   196 A B732 A632        CONV       LDAA      $32,X
>   197 A B734 2601                   BNE       C1
>   198 A B736 4C                     INCA
>   199 A B737 9720        C1         STAA      RATE
```

```
>   200 A B739 4F                    CLRA
>   201 A B73A E634                  LDAB      $34,X
>   202 A B73C 05                    LSLD
>   203 A B73D 05                    LSLD
>   204 A B73E 05                    LSLD
>   205 A B73F 9706                  STAA      A_INT
>   206 A B741 39                    RTS
>   207 A
>   208 A B742 1209204D   ELAB       BRSET     A_SW,#$20,E1
;TESTA
> A1/B1 ? MIDI ON/OFF
>   209 A B746 A631                  LDAA      $31,X
>   210 A B748 44                    LSRA
>   211 A B749 44                    LSRA
>   212 A B74A 9722                  STAA      TEMP
>   213 A B74C 12098006              BRSET     A_SW,#$80,E0
;TESTA
> SW A3/B3   ? SCALA 12/M
>   214 A B750 BDB794                JSR       SCALA
>   215 A B753 CE1000                LDX       #$1000
>   216 A B756 9102      E0          CMPA      A_NT1
>   217 A B758 2739                  BEQ       E1
>   218 A B75A 9103                  CMPA      A_NT2
>   219 A B75C 2735                  BEQ       E1
>   220 A B75E 9700                  STAA      A_NTON
>   221 A               *
>   222 A B760 9606                  LDAA      A_INT
>   223 A B762 270D                  BEQ       EEE
>   224 A B764 9600      EE0         LDAA      A_NTON
>   225 A B766 9001                  SUBA      A_NTOFF
>   226 A B768 8130                  CMPA      #$30
>   227 A B76A 2301                  BLS       EE1
>   228 A B76C 43                    COMA
>   229 A B76D 9106      EE1         CMPA      A_INT
>   230 A B76F 2F22                  BLE       E1
>   231 A               *
>   232 A B771 9600      EEE         LDAA      A_NTON
>M68HC11 Absolute Assembler   Version 2.70C:MA03.ASC
>
>
>   233 A B773 16                    TAB
>   234 A B774 BDB7B8                JSR       N_ON
>   235 A B777 D601                  LDAB      A_NTOFF
>   236 A B779 BDB7CD                JSR       N_OFF
>   237 A B77C
> 9603                   LDAA      A_NT2                    ;AGGIORNA CODA
NOTE
>   238 A B77E 9701                  STAA      A_NTOFF
>   239 A B780 9602                  LDAA      A_NT1
>   240 A B782 9703                  STAA      A_NT2
>   241 A B784 9600                  LDAA      A_NTON
>   242 A B786 9702                  STAA      A_NT1
>   243 A B788 13094007              BRCLR     A_SW,#$40,E1
;TESTA
> SW A2/B2   ? 1/3 NOTE
>   244 A B78C 9600                  LDAA      A_NTON
>   245 A B78E 9701                  STAA      A_NTOFF
```

```
>  246 A B790 7F000F              CLR     A_ARFLG
>  247 A B793 39         E1       RTS
>  248 A B794
>  249 A B794 4F         SCALA    CLRA
;ATTN
> USA REGISTRI D, X, Y
>  250 A                 *        PSHX
>  251 A B795 D622                LDAB    TEMP
>  252 A B797 CE000C              LDX     #$000C
>  253 A B79A 02                  IDIV
>  254 A B79B 18CEB7F4            LDY     #TABLE
>  255 A B79F 183A               ABY
>  256 A B7A1 50                  NEGB
>  257 A B7A2 DB22               ADDB    TEMP
>  258 A B7A4 18EB00             ADDB    $00,Y
>  259 A B7A7 17                  TBA
>  260 A                 *        PULX
>  261 A B7A8 39                  RTS
>  262 A
>  263 A B7A9
> B7102F      TX_A      STAA    $102F                    ;TRASMETTE VAL
> CONTENUTO IN A
>  264 A B7AC
> 18CE1000              LDY     #$1000                   ;RITARDO  MS
????
>  265 A B7B0 1809      T1        DEY
>  266 A B7B2 26FC                BNE     T1
>  267 A B7B4
> B6102E               LDAA    $102E                    ;PREDISPONE
> NUOVAMENTE LA SERIALE
>  268 A B7B7 39                  RTS
>  269 A
>  270 A B7B8 B6102E    N_ON      LDAA    $102E
;PREPARA
> LA SERIALE *  INPUT REG B
>  271 A B7BB 8690                LDAA    #$90
>  272 A B7BD BDB7A9             JSR     TX_A
>  273 A B7C0 17                  TBA
>  274 A B7C1 8B28               ADDA    #$28
>  275 A B7C3 BDB7A9             JSR     TX_A
>  276 A B7C6 A633               LDAA    $33,X
>  277 A B7C8 44                  LSRA
>  278 A B7C9 BDB7A9             JSR     TX_A
>  279 A B7CC 39                  RTS
>  280 A
>  281 A B7CD B6102E    N_OFF     LDAA    $102E
;PREPARA
> LA SERIALE  * INPUT REG B
>  282 A B7D0 8690                LDAA    #$90
>  283 A B7D2 BDB7A9             JSR     TX_A
>  284 A B7D5 17                  TBA
>  285 A B7D6 8B28               ADDA    #$28
>  286 A B7D8 BDB7A9             JSR     TX_A
>  287 A B7DB 4F                  CLRA
>  288 A B7DC BDB7A9             JSR     TX_A
>  289 A B7DF 39                  RTS
>  290 A
```

```
>M68HC11 Absolute Assembler    Version 2.70C:MA03.ASC
>
>
>  291 A B7E0
> B6102E       A_ANOFF    LDAA       $102E                        ;TRASMETTE
> ALL_NOTES_OFF SUL MIDI CH 0
>  292 A B7E3 86B0              LDAA       #$B0
>  293 A B7E5 BDB7A9            JSR        TX_A
>  294 A B7E8 867B              LDAA       #$7B
>  295 A B7EA BDB7A9            JSR        TX_A
>  296 A B7ED 8600              LDAA       #$00
>  297 A B7EF BDB7A9            JSR        TX_A
>  298 A B7F2 39                RTS
>  299 A
>  300 A                        END
>SYMBOL TABLE:   Total Entries=    52
>
>ARL                B685      E1                 B793
>AR_DEL             0023      EE0                B764
>AR_DLY             B682      EE1                B76D
>AU1                B67F      EEE                B771
>AU_RG              B667      ELAB               B742
>A_ADC              0007      FTOV               B724
>A_ANOFF            B7E0      INCR1              B69B
>A_AR               000E      INCR2              B6A5
>A_ARFLG            000F      INCR3              B6B8
>A_INT              0006      INCREM             B68A
>A_LSB              000D      INIT               B600
>A_MSB              000C      IPORTC             0003
>A_NT1              0002      I_RTN              B6D3
>A_NT2              0003      M1                 B65B
>A_NTOFF            0001      MAIN               B640
>A_NTON             0000      N_OFF              B7CD
>A_SW               0009      N_ON               B7B8
>A_VEL              0005      PORTC              1003
>C1                 B737      R1                 B643
>CONV               B732      R2                 B64A
>DECR1              B6E9      RATE               0020
>DECR2              B6F3      SCALA              B794
>DECR3              B706      T1                 B7B0
>DECREM             B6D7      TABLE              B7F4
>D_RTN              B720      TEMP               0022
>E0                 B756      TX_A               B7A9
>
>Total errors: 0
```

Appendix I